Technology Opportunity

Power Quality of Spacecraft Power Systems

NASA Lewis is modifying utility system-based software for power quality evaluation, to make it applicable to spacecraft. The intent is to fully develop the software to include components and subsystems commonly found in spacecraft power systems.

Potential Commercial Uses

- Identification and evaluation of system harmonic resonance(s) and their attendant voltage distortions and equipment malfunctions
- Quantification of system harmonic content (i.e., total harmonic distortion, THD)
- Guidance on filter design and sizing to eliminate/minimize harmonic effects

Benefits

- Applicable to both utility and spacecraft power systems
- Accepts wide frequency range
- Guides optimal placement of filters in voltage-stressed areas, thereby reducing costs

The Technology

The software HARMFLO was developed by the Electric Power Research Institute (EPRI) to analyze and evaluate HARMonic power FLOw within a balanced three-phase utility power system. NASA Lewis, through its Faculty Fellow Program, has developed an early stage, improved version of HARMFLO that is applicable to a single-phase power system characteristic of spacecraft. Although the results from this initial grade improvement are limited, they correlate reasonably well with selected published data of a high-frequency spacecraft test bed.

The original HARMFLO can be used to evaluate 60-Hz, three-phase utility power systems with nonlinear, harmonic-rich loads. The modified HARMFLO is applicable to a 60-Hz, three-phase balanced system, or a wideband frequency (up to 20 kHz) single-phase system, with source- or load-end harmonic distortion; it can, also, determine system harmonic content and resonances. The current version of the modified HARMFLO contains a mathematical model of a representative inverter (i.e., dc-to-ac converter), and a single-phase voltage-controlled rectifier, which form part of a high-frequency spacecraft test bed. Some simulated and test results are compared in figure 1.

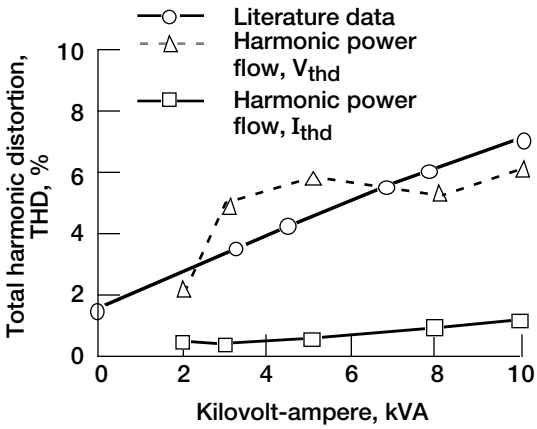

Figure 1.—Comparison of results of bus voltage THD vs. kVA loading from harmonic power flow program and test data from 20-kHz test bed. Current THD vs. kVA loading included. (Inverter uses a 2.0 μf series capacitor; p.f. = 0.8, lagging.)

Options for Commercialization

Industry partners are needed for cooperative development of a commercial version of the software, which would include other elements of spacecraft electrical power systems.

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